

Impact of alcohol on self-motion perception and reflexive eye movements: a human model to investigate the role of cerebellar impairment in visuo-vestibular integration

Summary of the project

To interact with our environment, we need to constantly estimate our orientation and our motion in space. This process requires a perfectly tuned processing of several sensory cues, prominently from vision and vestibular sensory organs. Such tuning is achieved by the cerebellar activity. Alcohol intake is well known to alter our ability to correctly perceive and plan our motion. Alterations in the sensory processing are known from studies on the effect of alcohol on reflexive responses. How such effects cause disorientation and perceptual illusion, however, is unclear. The results of the studies on vestibular reflexes (e.g. shorten duration of spinning signals) are indeed inconsistent with the perceptual reports of people under the effect of alcohol. This suggests that a possible dissociation of reflexive and perceptual processing might be unveiled by alcohol. Patients affected by cerebellar disease, also manifest alteration of the processing of self-motion cues. The consistency between reflexive and perceptual responses, however, is preserved through these alterations, supporting the notion of a shared processing. Following up on our last project supported by the SSA, using alcohol as a model to study gaze disorders in patients with cerebellar disease, we aim to evaluate whether such parallel can be extended to self-motion perception, navigation and disorientation.

We hypothesize that alcohol-induced disorientation and drop of navigation performance are due to detuning of the multisensory integration process responsible of merging visual and vestibular selfmotion cues. To test this hypothesis, we will investigate the effect of alcohol on processing of selfmotion sensory inputs at two levels: 1) comparing reflexive (eye movements) and perceptual responses to either visual or vestibular stimuli; 2) testing perception of self-motion in tasks with congruent (integration) and conflicting (suppression) sensory inputs. Specifically, we propose to compare perceived rotational velocity and slow phase velocity of the eye movements induced by steps of constant velocity rotation in darkness, or by optokinetic stimulation (full field pattern of random dot rotating around the subject) delivered with virtual reality head mounted display. Additive and subtractive combinations of the two inputs will also be tested. Data will be analyzed according to our established model for self-motion perception and compared with our data, previously acquired on cerebellar patients.

The outcome of this project will help to elucidate the processing of visual and vestibular selfmotion inputs in humans, possibly clarifying the role of the cerebellum. Alcohol, indeed, offers a unique opportunity to alter cerebellar control on such process. A similar approach is normally only possible with lesions in animal models, where access to perceptual responses is limited. Additionally, understanding the actual effect of acute alcohol intoxication on self-motion perception will provide insight on the critical disorienting factors, opening novel perspective to reduce the risk connected to alcohol abuse (e.g. driving while intoxicated).